P 13: Magnetic Confinement IV/HEPP IV

Time: Wednesday 11:00–12:20 Location: ELP 6: HS 3

P 13.1 Wed 11:00 ELP 6: HS 3

Non-linear free boundary simulations of resonant magnetic perturbations in ASDEX Upgrade — •Verena Mitterauer[1], Matthias Hoelzl[1], Matthias Willensdorfer[1], and ASDEX Upgrade Team[2] — [1]Max Planck Institute for Plasma Physics, Garching, Germany — [2]See author list of U. Stroth et al. 2022 Nucl. Fusion 62 042006

The suppression of ELMs by resonant magnetic perturbations RMPs in an ASDEX Upgrade plasma is modeled using the free boundary MHD code JOREK-STARWALL. The simulations are performed with fully realistic plasma parameters and plasma flows, which allows qualitative and quantitative comparisons with experimental observations, reveals important mechanisms, and forms a basis for more accurate predictive studies than previously possible. Simulations of the ELM suppressed state show a local structure in the radial displacement of the plasma around resonant surfaces that can be linked to the presence of magnetic islands. Together with recent experimental findings, this provides strong indications for the presence of a magnetic island chain at the pedestal top during ELM suppression in an ASDEX Upgrade discharge, contributing to resolving a long-standing open question. Furthermore, the transition out of the ELM-suppressed phase into an ELM-unstable state is modeled through an increase of the pedestal density values. The simulations allow to disentangle the role for suppressing ELM instabilities of the edge pressure profile evolution on one hand and non-linear coupling between peeling-ballooning instabilities with the RMP-driven perturbations on the other hand.

P 13.2 Wed 11:25 ELP 6: HS 3

Alfvenicity to Damping: Computational Insights from IMAS FALCON Integration and beyond — •Virgil - Alin Popa, Philipp Lauber, and Thomas Hayward-Schneider — Max Planck Institute for Plasma Physics, Garching, Germany

Building upon the robust infrastructure given by the Energetic Particle Workflow, we have integrated a new actor into the IMAS (Integrated Modeling and Analysis Suite) compliant workflow. The name of the new computational tool is FALCON (Floquet ALfven CONtinuum code). The model focuses on the continuous spectrum of SAWs in the ideal magnetohydrodynamic (MHD) limit. A formula for mapping Alfvenicity (given by FALCON) and kinetic damping (given by LIGKA) was developed. For this, various ITER scenarios were used for obtaining and validating the mapping formula. Furthermore, the workflow has been able to achieve significant speed-up in calculating the global linear properties of modes by exploiting analytical features and equilibrium profile information. This is of great importance when integrating the workflow into a transport code, where computational time is important.

P 13.3 Wed 11:50 ELP 6: HS 3

The change of Jacobian of Poincaré map of magnetic island X/O-cycles under three-dimensional perturbation field — •Wenyin Wei[1,2,3] and Yunfeng Liang[1,2] — [1]Forschungszentrum Jülich GmbH, Institut für Energie- und Klimaforschung - Plasmaphysik, Jülich 52425, Germany — [2]Institute of Plasma Physics, Hefei Institutes of Physical Science, Chinese Academy of Sciences, Hefei 230031, People's Republic of China — [3]University of Science and Technology of China, Hefei 230026, People's Republic of China

Based on the first-order shift formula of X/O-cycles under perturbation, the change of Jacobian (denoted as DP^m) of Poincaré map of X/O-cycles (of m toroidal turns) under perturbation is further investigated and formulated. Notably, neither the perturbation field nor the field to be perturbed is required to be axisymmetric or divergence-free for the formulae to apply.

In divertor configurations, the connection lengths of magnetic field lines in the scrape-off layer (SOL) are significantly affected by the DP^m eigenvalues of the outmost X-cycle(s). The number of the outmost X-cycle(s) depends on the experiment setup. Tuning the eigenvalues of DP^m of the X-cycle(s) closer to unity can markedly increase the connection lengths in the SOL, as the neighboring field lines will be more parallel to the X-cycles(s). Additionally, the width of a magnetic island is largely determined by the included angle of the two eigenvectors of DP^m of the adjacent X-cycle(s).

P 13.4 Wed 12:05 ELP 6: HS 3

Pedestal destabilization by 3D magnetic perturbation fields in tokamaks — •Jonas Puchmayr[1], Mike Dunne[1], Erika Strumberger[1], Matthias Willensdorfer[1], Hartmut Zohm[1], Florian Hindenlang[1], and ASDEX Upgrade Team[2] — [1]Max Planck Institute for Plasma Physics, Garching, Germany — [2]See U. Stroth et al 2022 Nucl. Fusion 62 042006

In H-mode tokamak plasmas, edge localized modes (ELMs) limit the achievable pressure gradient in the edge region and might cause severe damage in future fusion devices. Consequently, it is crucial to understand the onset of ELMs and methods to mitigate or suppress them. The onset of an ELM is typically well-described by the growth of magnetohydrodynamic instabilities at the plasma edge.

One method to mitigate or suppress ELMs is the application of magnetic perturbation (MP) fields. In this work, we use the linear extended MHD stability code CASTOR3D to show for the first time that symmetry-breaking by MP fields can significantly reduce the achievable stable pedestal pressure by up to 30%, resulting in mitigated ELMs. The destabilizing effect on the achievable stable pedestal pressure due to MP fields remains if ion diamagnetic drift effects, which strongly stabilize high-n ballooning modes, are included. The lowest pedestal top pressure resulting in the onset of MHD modes in 3D AUG plasmas has been found by interpolating between two equilibria featuring ELM mitigation and suppression, corresponding to the empirically observed pedestal pressure limit for complete ELM suppression.